

Modeling population response to anthropogenic threats for a long-lived reptile, the desert tortoise

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Background/Question/Methods

The decline in desert tortoise population densities and abundances since the 1970s has been attributed to numerous threats, leading scientists, land managers, and conservationists to describe the plight of the species as a “death by a thousand cuts.” Because the desert tortoise is threatened by so many anthropogenic stressors, and because the distributions and severity of these threats vary in time and space, the challenge of determining management priorities for the species is daunting. Further, because the desert tortoise is long-lived, has delayed sexual reproduction, and has long generation times, it is difficult for field-based studies to mechanistically link population response to the presence or absence of specific threats. We have attempted to overcome these difficulties through use of the HexSim population modeling software. HexSim makes it possible to examine single threats in isolation, and multiple threats in concert, to determine their individual and combined effects on populations.

Results/Conclusions

We developed a predictive habitat model that describes the potential for occurrence of desert tortoises based on the occurrence of importance habitat elements within the Gold Butte-Pakoon tortoise conservation area, located in southern Nevada and northwestern Arizona. We used this habitat model in HexSim, where we linked it to rules governing tortoise movement and population density. We obtained information on vital rates and movement behaviors from field studies and existing literature on the species. After developing a baseline tortoise model, we added threats (human presence, subsidized predators, grazing livestock, and wildfire) to evaluate population responses, and to prioritize the importance of each threat in limiting tortoise population growth.

Previous population models developed for turtle and tortoise species have determined that increased adult mortality, particularly of females, was the most influential factor limiting population growth. However, these models could not account for spatial variance in threat number or intensity. Our spatially-explicit model determined that threats with a widespread distribution were much more important in limiting population growth than those that were patchily-distributed over a limited area. Moreover, our results suggest that threats that cause habitat degradation over a broad area, such as livestock grazing and illegal off-road vehicle use, could be more important contributors to desert tortoise population decline than patchily distributed threats that cause mortality alone, such as the presence of subsidized predator populations or road mortality. These results challenge previous assumptions pertaining to desert tortoise population management, and set the stage for a re-evaluation of management priorities.